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The Next California Economy:
Hybrid Technologies

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Introduction

The California energy crisis, which was a challenge and even an opportunity (Clark, 2001) had been attributed to a number of issues. The economic experiences labeled it a "flawed' or even "dysfunctional" market due to not being structured properly (Economist, July and August 2001). Economic experts even wrote an Energy Manifesto in early 2001 that called for California to let market forces do their work and all would be well (NL, 2001). Prestigious institutions for energy research proclaimed California's energy market problems were the result of politicians and decision makers interfering with "market forces" (Borenstein et. al., 2001).

But the criticism did not stop there. International groups claimed that the market was never created in California to "properly allow " energy supply and demand" to take place. The Congressional Budget Office declared that California was an anomaly (CBO, 2001). The market was simply done wrong. President Bush and his appointees to the Federal Energy Regulatory Commission sounded the same theme. Until as Skelton (2002) wrote in the Spring of 2002, the "smoking gun" was found. California was subject to energy shortages that were aggregated by market manipulation. Evidence gathered since by the California Attorney General's Office and the California Public Utility Commission appear to substantiate the allegations.

When comparisons are made with other countries and states (Bachrach, 2001), it is clear that variations exist in each energy sector according to governmental policies. The common denominator over the last decade, however, has been de-regulation or as they call it in Europe "privatization" and "liberalization." Herein is the fundamental flaw -- energy is a public good and delegated to the public sector to oversee for every citizen, much like water, waste, and the environment.

While California is pursuing legal remedies and to secure its energy supply, the energy challenge has meant that the State must create a new energy sector. Indeed, As California Governor Davis said, the state needs to achieve "energy independence" (Davis, 2001) so that such market manipulation does not occur again. More importantly, the State needs to diversify its energy supply and expand into clean renewable energy sources. These public good initiatives take resources that promote intermittent resources and provide cost competitive energy.

From California Energy Crisis to Challenges and New Opportunities

In 2000 research began in which Lund and Clark (2001) published the first of several articles on renewable energy papers in the context of nation-state power systems labeled "Civic Markets" (2002), Lund (2001) and Clark (2003). Civic markets are the combination of public oversight with private sector companies providing goods and services under contracts, procurement and bond financing mechanisms. In some cases, these companies might form new firms that include government appointed officials on their boards (Clark and Jensen, 2001).

The key is that government needs to be involved in the creation and decision-making of companies that impact public sectors like energy (Clark and Morris, 2002). Energy, like water, waste and the environment (including atmosphere) is a public good. As such, public oversight must be applied to these sectors. California has the evidence to demonstrate why "public monopolies can not give way to private ones". Instead, any government must exist to protect and promote the public good.

This perspective is very different from prior California republican administrations as noted by past CPUC President and current Commissioner Loretta Lynch in late 2002:

> In December 1982, Gov.-elect George Deukmejian inherited the finest energy policy and regulatory agencies in the nation. By December 1998, Gov.- elect Gray Davis was left with a California that had dismantled its energy policy and hobbled its regulators in reckless pursuit of deregulation. The Wilson administration had stripped California of its ability to supply its citizens' energy needs and protect its economy from energy predators. In so doing, deregulation ideologues gave energy marketeers a golden opportunity to loot our economy -- and that's exactly what they did. (Lynch, 2002)

Governor Davis said in his State of the State address in January 2001 that, “a dysfunctional energy market, driven by out-of-state energy companies and brokers, is threatening to disrupt people’s lives and damage our economy.” Since then the facts, documents and court records concur with the Governor’s analysis. Energy is a “common good” or public trust that can not be left to the devices of “market forces.” The Governor has stated, and growing choruses of citizens concur that “skyrocketing prices, price-gouging and an unreliable supply of electricity” must be part of the responsibility of government.

Subsequently, emergency sessions and measures in the California from 2000 through 2002 yielded many bills that included formation of the California Power Authority charged with the mission of providing reliable "clean" energy to the State (CPA, 2002) along with conservation/efficiency programs (Consumer Agency, 2001) and emergency services (Consumer Agency, 2001). By the summer of 2002, California Governor Davis signed a "greenhouse gas" bill and soon thereafter a Renewable Portfolio Standard" of 20% by the year 2017 (OPR, 2002). Even perhaps more significant, based on the Commission for the 21st Century (Commission, 20010, the State enacted a law for an Environmental Goals Policy Report (EGPR) which would for the first time in over 25 years require the State to work with local communities in planning for the future (OPR, 2002).

By the end of 2002, the "five-member California Public Utilities Commission unanimously voted to cancel an order from April 20, 1994, that set the state on a course advocates said would bring cheaper electricity through free-market competition, letting homeowners and businesses choose their power provider. Instead, prices soared, supplies tightened and blackouts resulted during 2000 and 2001." (Rose, 2003). Commissioner Lynch put it more bluntly, since the State could not also get federal support "the CPUC has relentlessly pressed the Federal Energy Regulatory Commission to order the power-gougers to pay back what they plundered. We provided the FERC with clear evidence of the power-sellers' wrongdoing, and the key players now admit to it. Yet the FERC

stonewalls California's claims that California was swindled and that the state is entitled to a $9 billion refund from the manipulators. (Lynch, 2002)

Rose quoted CPUC Commissioner Carl Wood as saying that "The commission should close this deregulation proceeding, not just because there is no continuing need for it, but also because it was a disaster for ratepayers, utilities and their employees," Commissioner Wood called deregulation "the most expensive public policy mistake in the history of California." The disaster was caused, he said, by the former utility commission's "almost religious belief in market forces rather than regulation." (Rose, 2003)

Crafting a new energy market in California is a daunting task. For example, Clark and Bradshaw (2003) put forward the concept of "Agile Energy Systems" as necessary in any nation or country to protect and advance the public good. Quarterly financial returns or "short-termism" for private companies will not achieve societal goals (Demirag, 1998). Energy systems must be far more dispersed, distributed and regional (Isherwood, 2000) especially if energy is to be both "clean" and primarily renewable and reliable or guaranteed to all citizens. California had always assumed the latter role and with the energy challenge in 2000-2002, took upon itself to advance and set renewable energy goals.

De-regulation -- lessons learned

From a September 23, 1996 Press Release, then Governor Pete Wilson called energy de-regulation "landmark legislation" and said it was "A major step in our efforts to guarantee lower rates, provide customer choice and offer reliable service, so no one is literally left in the dark" (Wilson, 1996). As noted above none of that happened. Instead California, like many other states saw a few companies control energy supply and generation. Hence, market manipulation could be done by simply controlling the electrons flowing into the state.

The "market power" that most academics, politicians and some businesses expected to gain from deregulation turned into market monopoly for the generators that were selling electricity to California. Benson reports in late 2002 that utilities -- central grid operators -- see local communities and cities "unplugging" from the energy system. Deregulation has been rolled back with increasing numbers of communities now passing ballot measures for funds to underwrite their own independent energy systems (Benson, 2002).

As economic commentator Robert Kuttner labels de-regulation in a BusinessWeek article, "Enron (is) a powerful blow to market fundamentalists". In other words, says Kuttner, for decades academics have taught what is referred to as "neo-classical" economics to "gullible undergraduates and journalists, (saying) that there is no such thing as the public interest." The Enron collapse proved to Californians, and now the nation, how wrong and how dangerous such an economic ideology was.

Kuttner adds that, while the de-regulated energy sector had just taken root in California, the "de-regulated" transportation industry had been acting in its own best interests and against the public interests for over a decade by reducing costs, cutting corners, services

and security. He makes a compelling argument that certain sectors (energy, environment, waste, transportation among them) are in the public good and need to be public and private partnerships under what can called “civic markets. Clark and Morris (2002) note how this process worked in California when the State government sought to lead a collaboration between industry and the California Independent System Operators (CAISO) for scheduling intermittent resources into the grid.

Upon reflection of the events from 911, some experts wonder if part of the problem with the transportation (e.g. airline industry) was the same thing: de-regulation of that industry meant lower costs to be competitive and hence savings drawn from inexpensive security measures. Today, of course, air transportation is now once again "regulated" with the presence of newly trained workers and more sophisticated equipment.

Many reasonable observers now argue that while energy de-regulation was a failure in California the sector should not be re-regulated either. Nor should the energy sector be subjected again to the so-called “market forces” or business “power” advocated by most free market economists. The past few years in California saw enormous financial advantage taken by out-of -state energy suppliers, Enron among them. The issue of energy generators reaping exorbitant profits from the public can not be tolerated again under any political administration. Closer scrutiny is being taken on the federal level and internationally in Asia and Europe.

As Commissioner Lynch noted (Lynch, 2002):

> FERC ignores it all, and continues to push its deregulation agenda at the expense of the American public. With a fervor that flouts reality, the agency whose duty is to protect the energy-buying public instead shields the wrongdoers in order to "let deregulation work." This bitter lesson for California can only be remedied by Congress' curbing both the energy-sellers' market power and the FERC's actions of covering its back by refusing to enforce the law.
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> The harsh lessons of deregulation make it clear that we must act to protect our own interests. The Legislature and Gov. Davis have scaled back and even suspended some of the more pernicious aspects of the 1996 deregulation law. Now is the time for California to complete that job and eliminate all vestiges of its now infamous deregulation experiment.
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> Since the turn of the century, when the electricity industry was in its infancy and unregulated energy-sellers first held the nation hostage, the nation understood the value of regulating the energy industry. As the Federal Power Act made clear then, California must reiterate now, the power industry overseers and the power-sellers are accountable to the public.

Enormous advances were made in public policy in California as it sought to regain control over its energy. However, the system still remains transitional and in need of transformation. Lowest costs for energy can not, for example, be the only variable for energy supply. Simple neo-classical economic models do not work with public sector goods and services (Clark and Fast, 2003). Historically, lowest costs for energy or

environmentally sound technologies, like many other public goods has been due to large sums of federal and government research and development investment (Science, 1997).

However, with private companies, the concern for making profits does not lend itself well for new research and development (Clark, 1997). Energy in particular suffers from the stigma of being perceived as "stogy industries" of smoke stacks and antiquated technologies. Hence, companies and employees are not provided with funds and resources for innovation and creation of new technologies. This was not the case when the companies were public or regulated. Under de-regulation, research and development suffered.

Despite California's attempt to mitigate this problem through Public Interest Research Funds, for example, the effort tends to be too little and take too long. Advances in fuel cells (CFCC, 2002) are slow. Energy storage devices in general (Cooper et al., 1995) while clearly needed for providing energy reliability for intermittent energy such as wind and solar, are not receiving the funding for the development of such systems (Cooper and Clark, 1999). Energy storage devices or "hybrid systems" for example need to be supported (Isherwood et al. 2000; see Appendix A). Public policy needs to advance and finance these clean energy generation systems.

Hybrid systems - or a combination of two or more technologies (that is wind with pumped storage or solar with fuel cells -- here both renewables are linked with storage devices) can be seen as the future for solving the issue of intermittent resources both as firm energy source and qualifying the energy produced as "base load." (NPS, 2002) Northern Power Systems has implemented such systems with good numbers in terms of costs and results (see Appendix B). A number of companies are beginning to explore the possible links and hence hybrid technology systems for their operations.

Hybrid systems offer substantial benefits for both "green grid power" and renewable-only systems, which are often not the most reliable or economic approaches. Some benefits of hybrid systems from Northern Power System (2002) may include:

Cost savings:

- Reduced fuel costs, including storage, handling, and maintenance
- Reduced utility power consumption, especially during expensive peak hours
- Buy-downs, tax credits, other incentives reduce installation cost and shorten payback period
- Reduced impact of utility rate hikes

Environmental benefits:

- Reduced greenhouse gas emissions

- Improved efficiency
- Reduced fuel consumption
- Less potential for leakage and spills

High reliability:

- Uninterrupted power supply
- Reduced risk of financial losses due to power outages
- Reduced downtime

Energy independence:

- Lower vulnerability to power outages
- Own your own power supply
- Incorporate multiple energy sources

Some examples:

- Oak Creek Energy Systems plans to combine wind turbines with storage systems such as pumped storage or electronic storage to create a wind-driven system that can provide firm energy with some dispatchability.

- Sharp Solar Systems Division of Sharp Electronics is researching the combination of photovoltaics with electrolyzers and fuel cells and developing a control system to optimize its operation.

- SunLine Transit Agency in Thousand Palms, California has a number of experimental fuel cell buses, and they are making hydrogen fuel for the buses in electrolyzers powered by photovoltaic arrays.

What is obvious is that the energy cost numbers begin to "add" correctly and the power supplied is cost competitive. These systems were under development in Japan with strong government support for many years (Clark and Chung, 2000). Today they show that with systems over 1-3 MW the costs are extremely competitive. In fact, Sharp corporation has even demonstrated (late 2002) that it can provide and guarantee solar power for $.035 /kW which is competitive with natural gas costs today (Wiser, et. al., 2001).

Long-term Strategies for Diversified Energy Portfolio

Two basic ways to achieve agile energy systems: one is for on-site power generation (CPUC, 2002 and CEC, 2002); and the other is for regional systems (CPUC, 1999, CEC, 2002, and Bollman, 2002) that are fundamentally more like the internet (Rifkin, 2002) than the present central grid configuration. By the late fall of 2002 and looking toward the future, California has begun to rebuild its infrastructures. Governor Davis (2003) has

called for a "Building California" program that focuses on its infrastructures as well as developing its workforce and advanced technologies. With a large budget deficit in large part created by the energy de-regulation, the State now needs to look to its historical creative and entrepreneurial spirit for rebuilding.

The tools, including financial resources and workforce development are local -- regional. The voters have passed over $40 billion in bond measures while the university system continues to lead the world in research and development. Jobs are created and business developed from a variety of emerging technologies, including the energy and environmental sectors.

For example, there is now a shift in the roles in the California Public Utilities Commission (CPUC) and the California Energy Commission (CEC) as seen in recent governmental appointees to these Commissions. Now there will not only be an oversight function for the Commissions, but a specific economic development role. In other words, California has provided large contracts and projects for energy programs in the State. Now it wants the companies to be both located and grown in the State. In other words, California may be the first nation to define and practice "sustainable development" -- in both the scientific and economic context.

There are enormous amounts of money at state. Consider that "Overall, FERC is reviewing contracts valued at about $40 billion with more than a dozen companies. California has asked for termination of the contracts or for costs to be cut in half. In a related matter in San Francisco yesterday, California's disastrous experiment with energy deregulation ended quietly in a brief order issued by state utility regulators. (Rose, 2003)

The second area is on-site power generation. Here typical accounting "cost benefit analysis" are the norm but fail to focus on real costs of energy (e.g. fuel source, historical technological development, health costs, and future needs of society). Thus while it may be cheaper and "cleaner" (then goal or oil) to have natural gas for as a fuel source, the financial analyses fail to consider the original costs for exploration, discovery, and distilling the fuel as well as the particulates health impact.

What is particularly interesting are the lack of data on historical costs for any fuel infrastructure, such as natural gas. Aside from its dramatic increased use in energy fuel supply, natural gas is being increasing used for vehicles and fleets. However, what were the original research and development costs for natural gas -- and more importantly who paid for them? Much of the research and development was subsidized in the USA by the federal government; and in other countries by various government entities.

Critical to the costs of natural gas or other energy supplies are the transmission or pipe lines. Again, consider the costs for these systems when they were originally proposed? And what might the costs today for new systems that use renewable energy? The comparison is even more compelling when the costs for transmission are seen as being underwritten or financially supported by national governments.

The future of agile energy systems might be advanced far more aggressively, if, as in with historical energy power systems (generation and transmission) that government

support and financing played a key role. When governments on the local and regional level are involved, as is increasingly occurring today in California, the solutions to bringing on-line more clean intermittent energy is more than just probable. It becomes, with strong state support, financiable and eminent. That is why California can see a Hydrogen Economy future -- sooner than later (Rambach, 1999).

Related to both gird and on-site energy generation is distributed energy generation (DG) or as they refer to it in Europe, combined heat and power generation (Münster, 2001) or CHP. The concern for distributed energy systems is not new. In Europe and especially the northern most countries, DG or CHP has been fundamental to basic energy needs for decades. Most of the systems, however, are very dependent upon fossil energy of some sort. Natural gas within the last decade has been the most pronounced (Lund, 2001) due to its availability, reliability and low costs. However, wind and biomass are both strong competitors and increasing in use (Lund, 2001;and Bolinger and Wiser, 2002a and b).

In the USA a growing concern for DG can be seen to follow the European pathway with natural gas dominated systems leading the way. Public entities in California (CPUC, 1999; CPA, 2002 and CEC, 2002) all argue for the need for DG but few integrate intermittent resources, as they are considered too costly and unreliable. New analyses and programs (Morris, 2003) are needed to direct this important concern for regional energy systems that incorporate renewable energy technologies (Clark, 2003) and focus on the future energy infrastructure needs such as hydrogen (Rifkin, 2002).

Clean Energy Plans: economics and competitive costs of intermittent resources

California has already begun comprehensive planning for California's future energy needs. We will need to build new plants, but we need not be at the mercy of private contractors who deign to build for us only at exorbitant prices. Instead, the PUC is working on supply plans that integrate our need for modern, environmentally sound power plants with our vision for using more solar, wind, geothermal and biomass energy sources. And California's energy plan must incorporate energy efficiency and conservation into our daily lives.

CPUC Commissioner Lynch notes that "Policymakers can provide a framework for sound investing without speculation. If the state Public Employees Retirement System (CalPERS) could invest in partnerships with Enron, it can more wisely invest in regulated California power plants and renewable energy sources, where the PUC can guarantee returns and at the same time can protect the public interest.

The road ahead is difficult. We must protect ourselves against new deregulation schemes. California's goals of environmentally sound energy, provided at just and reasonable prices, lie still ahead. We can only reach these goals if we stay the course of fiscal discipline and energy regulation in the public interest. (Lynch, 2002)

A number of government mechanisms are also available. Procurement is critical especially for state and public buildings. As the California Consumer Affairs Agency noted in its "Blue Print for Sustainable State Buildings" (CAA, 2001), the driving force for clean energy and lower costs should be the state buildings. Along with cost accounting based on life cycle analyses (IGAWG, 2002), the competitive costs for renewable on-site energy technologies can be competitive.

However, "competitive aggregation" can be another government-initiated tool for the purchase of goods and services. The California Power Authority along with the California Stationary Fuel Cell Collaborative did just that for fuel cell in the fall of 2001 (CFCC, 2002) and also for solar PV systems. While the Request for Bids list still exists, the actual funds for purchasing were not available. The competitive bid list may become a significant item with the newly passed $40 + Billion Bond funds passed in 2002.

A good example exists now for on-site generation with the Los Angeles Community College District. In 2001, the community passed a bond measure for $1.3 billion to renovate and rebuild the 30+ year old campus. Half of the funds were to be used for renewable technologies. In the Spring of 2002, the Board of Directors approved the contractors and building for "Silver Level LEEDS" standards at some for the campus buildings. Voters in the fall of 2002 then approved another $2+ Billion in bonds for the entire "greening" of the 9-campuses within the System. Similar measures passed 17 or the 19 Community College Districts in 2002, leaving the System with the potential to competitively aggregate goods and services bidders.

Hybrid or linked technologies are new approaches for the energy industry to combine various technologies to accomplish the purpose of shaping the flow of power from an intermittent renewable resource into becoming firm or base load energy generation. Such a strategy provides energy generators with far more operational flexibility and diversity of fuel supply (Bernstein, 2001). This approach can increase the value of the product to the end user, and also make it easier for the CAISO to manage by making the powerplant look more like a gas-fired turbine in its operational characteristics, creating reliable clean energy at low competitive prices.

Hybrid systems furthermore can improve an energy portfolio by minimizing both financial and energy risk. These systems increase versatility and create a seamless energy supply that mixes clean renewable and conventional fuels with traditional grid power. Integrated resource management need not be modeled on a bell shaped curve that is dependent on conventional fossil fuel resources, but be geared toward what some scholars are calling "flexible or agile resource management." (Clark and Bradshaw, 2003) Such hybrid systems exist today and have been documented / evaluated for years now. (Isherwood et. al, 2000)

Conclusions: toward a future for hybrid energy technologies

As CPUC Commissioner Lynch put it: "We cannot cede the protection of our economy to the federal government or 'the market'. Regulation is essential to guard critical services that can be monopolized by a few to the detriment of our families and businesses. The California Constitution recognizes this reality -- it requires energy-market regulation to prevent exploitation." (Lynch, 2002)

Intermittent resources can become firm base load energy when combined with other energy technologies and developed into agile systems. While more research and analysis needs to be done on the economics of these systems, it is clear that they are both regional and public sector supported as well as "overseen". The health needs of society, the future of citizens for power, and above all the independence of any nation-state depend on these new systems.

California appears to be the first “nation-state” to define and implement “sustainable development”. The Governor, State leaders and citizens are ready and willing to meet the challenge. As the Economist noted about the energy crisis last Spring 2001, the “world is watching for California to take the lead again” (Economist, July, 2001).

That process began in 2000, when the current energy crisis struck hard at all Californians. It was brought to its potential with policies in 2002 where California lead the world in greenhouse mitigation legislation and set renewable energy standards unmatched in the USA. And now Californians in the middle of a severe economic budget deficit will seek to implement these policies in 2003. True to the spirit and history of California, the public good for all its citizens will prevail.

References

Bachrach, Devra. “Comparison of Electric Industry Restructuring Across USA,” UC Berkeley and California Energy Commission, Governor Davis, Building for the 21st Century Infrastructure Commission, Sacramento, CA, August 2001, and in Appendix. Bay Area Economic Forum, "California at a Crossroads: Options for the Long-term reform of the Power Sector", McKinsey & Co. San Francisco, CA. October 2001, pp.1-56.

Benson, Mitchel, "As problems mount for utitilities, cities pull plug on deregulation: ballot measures across US attempt rollback of electricity deregulation", Wall Street Journal, November 3, 2002, electronic, mitchel.benson@wsj.com

Bernstein, Mark, "California Energy Market Report", Winter 2000-2001, Rand Corporation, Santa Monica, CA. January 2001.

Bolinger, Mark and Ryan Wiser, "Utility-Scale renewable energy projects: A survey of clean energy fund support", Clean Energy Funds Network, Lawrence Berkeley National Laboratory, Berkeley, CA. May 2002a: pp. 1-16.

Bolinger, Mark and Ryan Wiser, "Customer-sited PVs: A survey of clean energy fund support", Lawrence Berkeley National Laboratory, Berkeley, CA. May 2002b: pp.1-16.

Bollman, Nicholas et al. "Regionalism: Special report for California State Assembly", California Public Policy Institute, San Francisco, CA., 2002.

Borenstein, Severin, James Bushnell, Christopher R. Knittel, and Catherine Wolfram, "Trading Inefficiencies in California's Electricity Markets", University of California, Energy Institute, Power Working Papers Series, October 2001.

California Governor Gray Davis Office of Planning and Research (OPR), web site. 2002. http://www.opr.ca.govl

California Consumer Affairs Agency, "Flex Your Power Programs", Sacramento, CA. 2001.

California Consumer Affairs Agency (CAA), “Building Better Buildings: A Blueprint for Sustainable State Facilities,” Sustainable Building Task Force and the State of Consumer Services Agency, December 2001.
http://www.ciwmb.ca.gov/GreenBuilding/Blueprint/Blueprint.pdf

California Independent System Operator (CAISO). 2002. "Intermittent Resources Report", Folsom, CA, March 28, 2002. Website:
http://www.caiso.com/docs/2002/02/01/200202011116576547.html

California Energy Commission (CEC) 2002, "Renewable Energy Program: Annual Project Activity Report to the Legislature" (pub # 500-02-068) and Report Appendix, (pub # 500-02-068A) http://www.energy.ca.gov/reports/index.html

California Energy Commission (CEC): The CEC provides cash rebates on eligible renewable energy electric-generating systems. Rebates of $4.5 per peak watt, or 50 percent off your system purchase price (whichever is less) are available for systems up to 10 kW. Fall 2002. http://www.energy. ca.gov/greengrid/index.html

California Public Utilities Commission (CPUC): The CPUC program provides $4.5 per peak watt (or 50%, whichever is less) for photovoltaic systems between 30 kW and 1 MW. For more information contact John Galloway. 2002. (jhg@cpuc.ca.gov).

California Power and Conservation Authority (CPA): The CPA PULSE program, Sacramento, CA. 2002. cpapublicloans@dgs.ca.gov.

California Public Utilities Commission (CPUC), "Definition of Distributed Generation", Decision #99-10-065, September, 1999.

California Public Utilities Commission (CPUC): "Rebate Program for on-site power generation", San Francisco, CA. 2002. (jhg@cpuc.ca.gov).

California Stationary Fuel Cell Collaborative (CSFCC), Governor's Office of Research and Planning; California Air Resources Board and the University of California, Irvine "National Center for Fuel Cells": Sacramento, CA. 2002 www.stationaryfuelcells.org

California Interagency Green Accounting Working Group (IGAWG) "A Five Year Energy Efficiency and Renewable Investment Plant for Public Buildings, Governor's Office of Planning and Research, Sacramento, CA. March 2002

Chapman, R.N., "Hybrid Power Technology for Remote Military Facilities," Power Quality Solutions/Alternative Energy Proceedings, September,1996: pp. 415-427.

Clark, Woodrow W. II, "Distributed Generation Public Policy", Energy Policy, London, UK, Elsevier, fall 2003.

Clark, Woodrow and Ted Bradshaw. Flexible Energy Systems in Complex Societies: the Case of the California Energy Crisis. Elsevier Press, London, UK, forthcoming, 2003.

Clark, Woodrow W. and Michael Fast. Interactionism: Toward a Science of Business and Economics. Inderscience Press, London, UK, forthcoming fall 2003.

Clark, Woodrow W. II, "The California Challenge: energy and environmental consequences for public utilities", Utilities Policy, Elsevier, UK, Nov 2002.

Clark, Woodorw W. and Gregg Morris, "Public-Private Partnerships: the case of intermittent resources", Energy Policy, Elsevier, Dec 2002.

Clark, Woodrow W. and Henrik Lund, "Civic Markets: the case of the California energy crisis", Journal of International Global Energy Issues,Inderscience, London, UK, 2001.

Clark, Woodrow W. II and J. Dan Jensen , The Role of Government in Privatization: An Economic Model for Denmark. International Journal of Technology Management Vol 21 Nos.5/6, . Inderscience, London, UK, 2001.

Clark, Woodrow W. II and RaeKwon Chung (Co-Directors), "Transfer of Publicly funded R&D programs in the field of climate change for environmentally sound technologies (ESTs). From Developed to Developing Countries: A summary of six country studies. Framework Convention for Climate Change, United Nations, Nov 2000.

Clark, Woodrow W. II., "Transfer of Publicly Funded R&D Programs in the field of Climate Change for Environmentally Sounds Technologies (ESTs) : From Developed to Developing Countries -- A summary of six country studies", UN Framework Convention for Climate Change, 1997.

Cooper, John F. with Dennis Fleming, Douglas Hargrove, Ronald Koopman and Keith Peterman, "A Refuelable Zinc/Air Battery for Fleet Electric Vehicle Propulsion," Paper presented to SAE Future Transportation Technology Conference and Exposition in Costa Mesa CA; Lawrence Livermore National Laboratory, Livermore CA. August 7-10, 1995.

Cooper, John F. and Woodrow W. Clark Jr. "Zinc Air Fuel Cell: an alternative to clean fuels in fleet electric vehicle applications", International Journal of Environmentally Conscious Design & Manufacturing, vol. 5 No.3-4, 1996: 49-54.

Commission on the Building for the 21st Century "Report". February, 2002. Co-Chairs Maria Contrares-Sweet and Guy Bustamonti, Business, Transportation and Housing Agency, Sacramento, CA. Website: http://www.bth.ca

Congressional Budget Office (CBO). "Causes and Lessons of the California Electricity Crisis". 2001.

Davis, Governor Gary., "State of the State" Sacramento, CA. January 9, 2001.

Davis, Governor Gary.,"State of the State", Sacramento, CA. January 8, 2002.

Demirag,I. Corporate Governance, Accountability and Pressures to Perform: An International Study. Oxford, UK: Oxford Un. Press, 1998.

Economist, "How to keep the Fans turning" , July 2001. Electronic version.

Economist, "California Economy: the real trouble", August 20 01. Electronic version.

Economist, "Economic Man, cleaner planet", Sept ember 01. Electronic version.

Environmental Goals and Policy Report (EGPR). Governor's Office of Planning and Research, Sacramento, CA. 2002. http://www.opr.ca.govl

Federal Energy Regulatory Commission (FERC), California Independent System Operators, "Intermittent Resources Ruling" Docket Nos. ER02-922-000 and EL02-51-000) <htttp://cips.ferc.fed.us/cips/default.htm> March 28, 2002.

Fuel Cell Partnership, "Bringing Fuel Cell Vehicles to Market", Sacramento, CA. 2001. www.cafcp.org/recent_event.html

Governor's Web Site. "Special Finance Assistance for Energy Efficiency and Renewable Programs", Sacramento, CA. August 2001-2002. Website: http://www.governor.ca.gov

Isherwood, William, J. Ray Smith, Salvador Aceves, Gene Berry and Woodrow W. Clark , II with Ronald Johnson, Deben Das, Douglas Goering and Richard Seifert, "Economic Impact on Remote Village Energy Systems of Advanced Technologies", University of Calif., Lawrence Livermore National Laboratory, UCRL-ID-129289: January 1998. Published in Energy Policy, Fall, 2000.

Kuttner, R. March 25, 2002. "The Road to Enron," The American Prospect.

Lund, Henrik, "Flexible energy system data in Denmark", draft report for Danish Energy Ministry, 2001.

Lund, Henrik and Woodrow W. Clark II., "Management of Fluctuations in Wind Power and CHP: Comparing Two Possible Danish Strategies" Energy Policy, Nov. 2002.

Lynch, Loretta, "Energy Future: beyond the deregulation debacle", San francisco Chronicle, Dec. 25, 02, electronic.

Morris, Gregg, "An economic model for renewable energy investments", internal draft model for the Interagency Renewable Agency Working Group, Governor's Office of Planning and Research, State of California, Sacramento, CA.unpublished 2003.

Münster, Ebbe, "Combined Heat ad Power: N ord Pool Exchange", PlanEnergi. Denmark. 2 June 2001 nord@planenergi.dk www.planenergi.dk

Nobel Laurettes (NL), "Energy Manifesto" University of California, Berkeley, 2001.

Northern Power Systems (NPS), "Newsletter: Hybrid Energy Systems", Vermont, Spring 2002.

Pickhardt, M. and Niederprum, M. 2002. "Welfare Effects of Electricity Market Deregulation in Germany" Western Economic Association International Annual Meeting, Seattle, July 2002.

Rambach, Glenn, Integrated renewable Hydrogen/Utility Systems" USDOE Contract number #DE-FC36-98GO10842, Desert research Institute, Reno, NV, December 14, 1999. Pp.1-64.

Rastler, Dan, "Distributed Resources: Year 2002 Highlights", Energy Research Producers Institute, Palo Alto, CA.: December 2002.

Revkin, Andrew C. "Climate Talks Shift Focus on How to deal with Changes", New York Times, November 3, 2002. Electronic

Rifkin, Jeremy, The Hydrogen Economy, 2003. New York, NY. Penquin, 2002. http://www.foet.org/JeremyRifkin.htm

Rose, Craig D. "FERC rules against state: power contracts are valid", Bloomberg Business News, Staff and news Services, Washington, DC>: January 17,2003, electronic.

San Francisco Public Utilities Commission and Department of Environment (SFPUC), The Electricity Resource Plan: Choosing San Francisco's Energy Future", San Francisco, CA., Nov. 2002.

Science, Special Secrtion,“Who Finances Research and Development”, vol. 275, March 21, 1997: 1729.

Skelton, George, "Smoking Gun Shoots Down Bush View of Power Crisis", Los Angeles Times, May 13, 2002, p. B5.

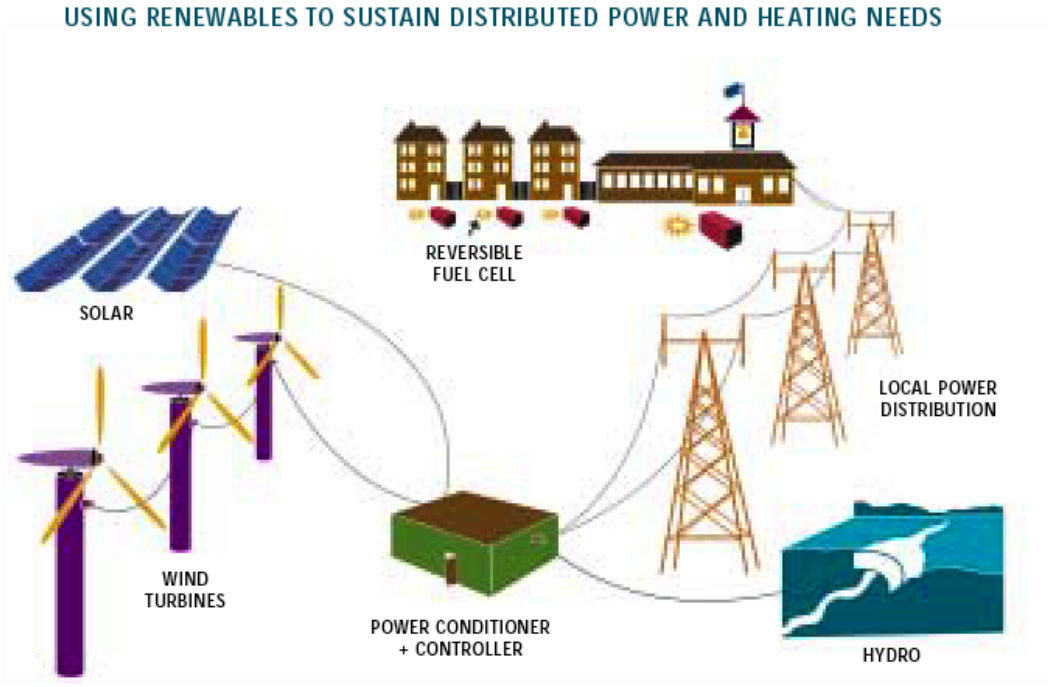
Wilson, Governor. Pete..Press release, "Energy Deregulation", Governor's Office, Sacramento, CA. September. 23, 1996.

Wiser, Ryan, Meredith Fowlie and Edward Holt, " Public goods and private interests: understanding non-residential demand for green power ", Energy Policy Vol 29. issue 13. November 2001 pp 1085-1097.

World Alliance for Decentralized Energy (WADE), "Conference Summary: 3rd International CHP and Decentralization Conference and USAID International Conference on Bagasse Cogeneration", New Delhi, India, October 2002, pp.1-2.

Appendix A **Distributed Energy Generation**

Source: Commission on the Building for the 21st Century "Report". February, 2002. Co-Chairs Maria Contrares-Sweet and Guy Bustamonti, Business, Transportation and Housing Agency, Sacramento, CA. Website: http://www.bth.ca



Appendix B Hybrid Energy Renewable Energy

Source: Northern Power Systems (2002) general engineering and cost estimates – actual results will depend on site conditions and equipment specifications.

Northern Power Systems has provided the following data:

- Engines, turbines, and fuel cells can all deliver combined heat and power (CHP) for facilities with significant heating or steam loads.
- Wind turbines are now delivering power at costs per kilowatt hour (kWh) that rival utility pricing, and photovoltaic technologies are frequently perfect for delivering power during peak air conditioning demand periods.
- Systems incorporating **multiple or hybrid technologies** are often the most cost-effective solutions based on facility needs, local utility costs, and State/Federal incentive programs.

Hybrid Renewable Technology Systems

Criteria	Photo-voltaic	Wind Turbines	Gas Engines (Diesel or Natural Gas)	Micro-turbines	Fuel Cells
Typical Capacity Range	Modular	10 kW - 4 MW	50 kW - 5 MW	30 kW - 250 kW	1 kW - 250 kW
Efficiency	Free Fuel	Free Fuel	30 -40%; up to 90% with heat recovery	18-28%; up to 85% with heat recovery	35-60%; up to 80% with heat recovery
Installed Cost ($/kW)	7,000 - 10,000	1,000 - 1,500	1,000 - 2,000	1,500 - 2,500	4,000 - 5,000
O&M Costs ($/kWh)	0.003	0.008 - 0.015	0.007 - 0.015	0.015 - 0.02	0.005 - 0.01
Hedge against electricity price volatility	High-solar energy is free	High-wind energy is free	Medium-dependent on natural gas or diesel prices	Medium-dependent on natural gas prices	Medium-dependent on hydrogen fuel source
Emissions NOx (lb/MWh)	Zero	Zero	0.5 - 2.2 Nat. Gas; 4.7 - 21.8 Diesel	0.44	0.01 - 0.03
Emissions SOx	Zero	Zero	0.006 Nat. Gas; 0.454	0.008	0.006

(lb/MWh)			Diesel		
Emissions CO2 (lb/MWh)	Zero	Zero	1,100 - 1,400 Nat. Gas; 1,400 Diesel	1,600	950 - 1,100
Reliability	> 99%	> 98%	> 98%	Should be very high	Should be very high since very few moving parts
Dispatch-able	No	No	Yes	Yes	Yes
Typical Incentives ($/watt) - California example*	4.50 up to 50% of project + potentially $1.5 in LA + 15% tax credit	4.50 up to 50% of project + 15% tax credit	1.00 up to 30% for waste heat recovery	1.00 up to 30% for waste heat recovery	4.50 up to 50% of project
Public Relations and Branding Value	Excellent	Excellent	Poor; Good with waste heat recovery	Good	Good

* Incentives in other states such as New Jersey, New York, and Massachusetts are also quite favorable.

Appendix C: Flexible and Hybrid Energy Data

Source: Henirk Lund, 2002

Table 1 Flexible energy systems compared with the reference

Scenario year 2030	Difference between the reference and the Flexible energy system	Difference between the reference and the Flexible system including transport
Electricity export	-11,86 TWh	-13,28 TWh
Fuel consumption		
- Natural Gas	-19,20 TWh	-8,20 TWh
- Petrol/Diesel		-20,83 TWh

CO_2 emission (In DK)	- 3,8 billion tons	- 7,6 billion tons

Table 2 Market revenue advantage of flexibility compared with the reference in year 2015

Average Market price DKK/kWh	Energy system	Import TWh	Import price DKK/kWh	Export TWh	Export price DKK/kWh	Net revenue Million DKK	Advantage of flexibility Million DKK
0.113	Reference	4.0	0.13	3.0	0.09	-270	
	Flexible	4.0	0.09	2.7	0.21	197	467
0.227	Reference	2.9	0.21	3.0	0.19	-34	
	Flexible	2.9	0.16	2.7	0.41	635	669
0.340	Reference	0.8	0.22	3.0	0.30	734	
	Flexible	1.3	0.20	3.2	0.60	1677	943

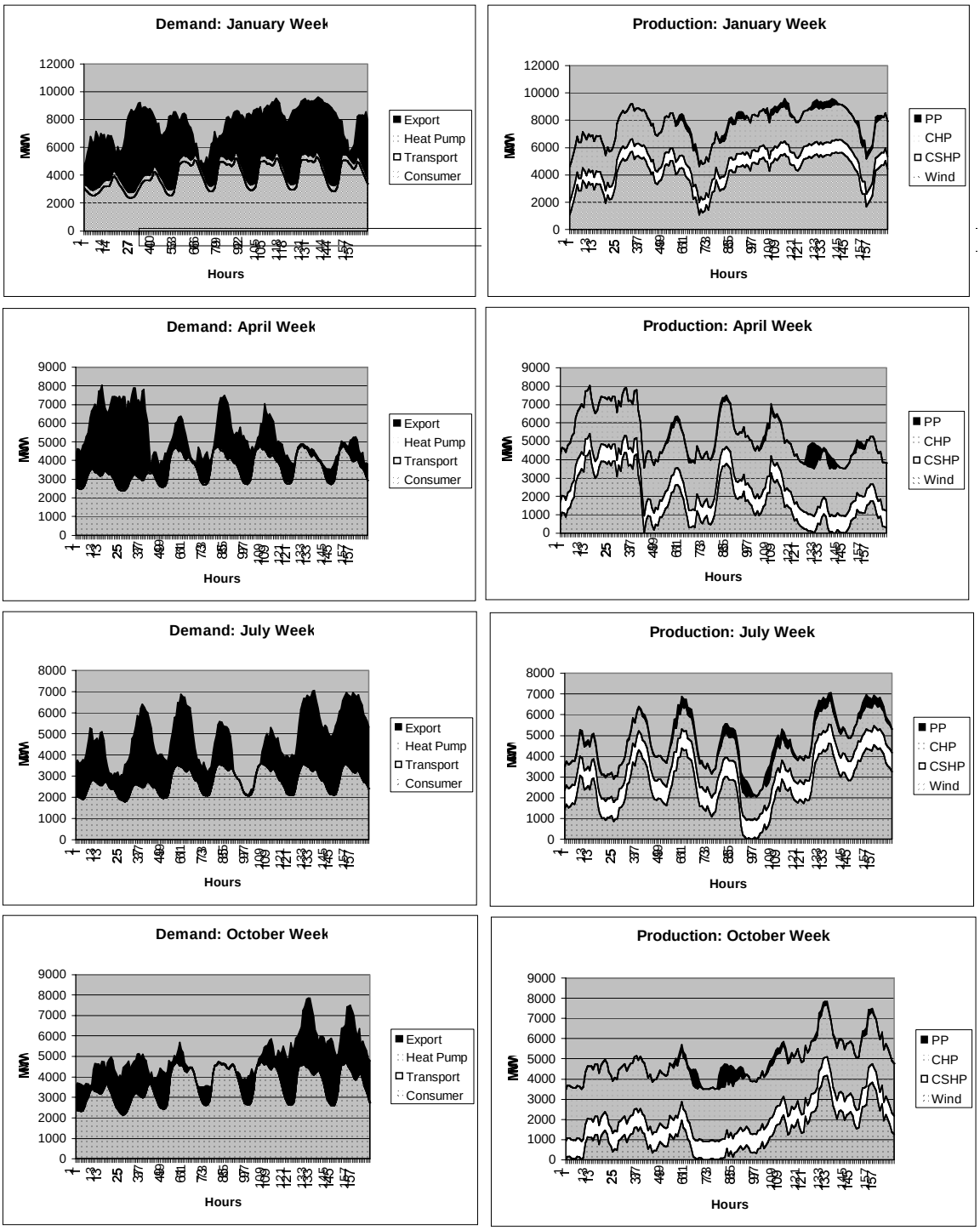
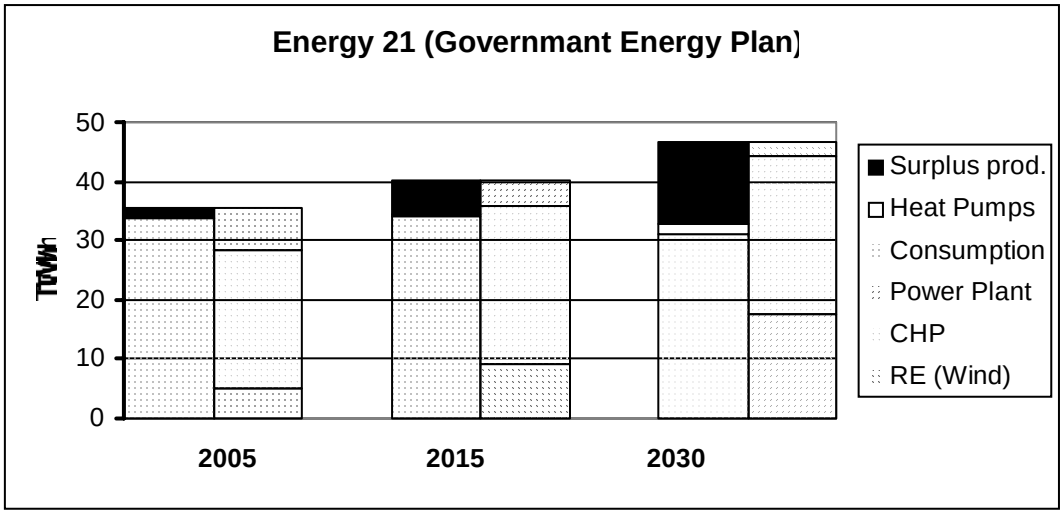


Figure 5 Surplus production (Export) when implemented with flexible energy systems including transport(PP = Power plants and CSHP = Industrial Combined Steam and Heat Power)

Figure 1 Electricity balance according to the Danish Parliament energy plan



"Energy 21".

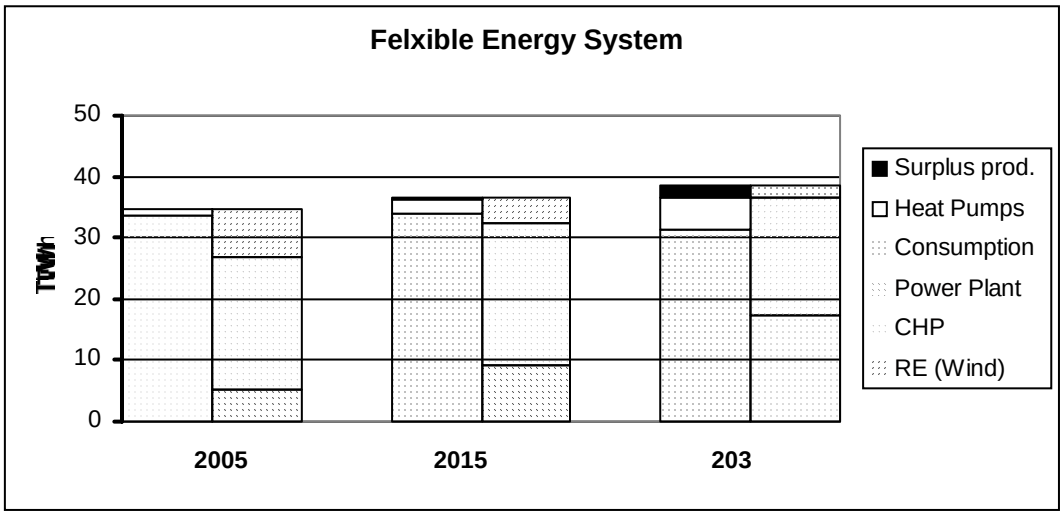


Figure 3 Electricity balance when implemented by flexible energy systems

Figure 4 Electricity balance when implemented by flexible energy systems including electricity for transport.

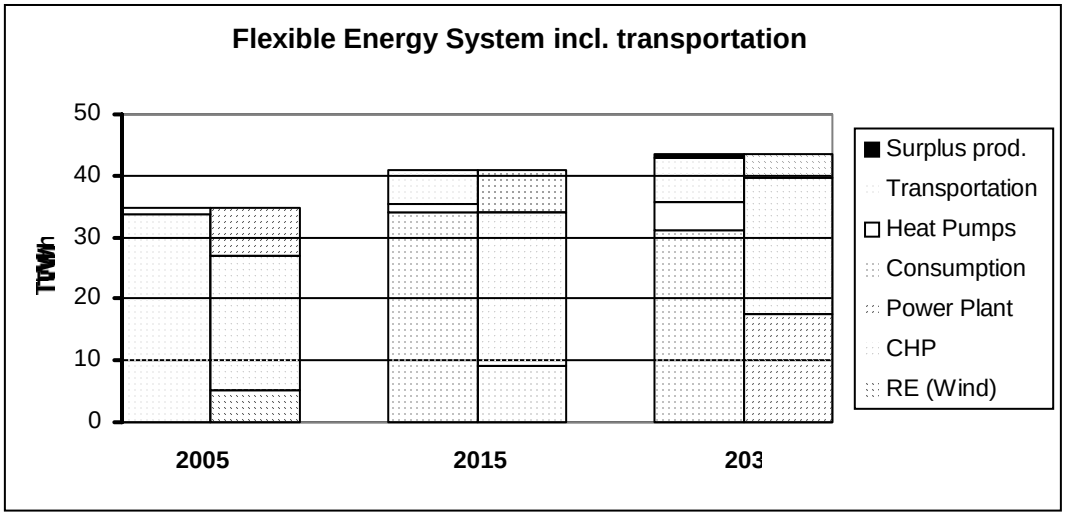


Figure 2 Surplus production (Export) in the Danish Parliament energy plan "Energy 21". (PP = Power plants and CSHP = Industrial Combined Steam and Heat Power)